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Abstract

HEAT TRANSFER INTENSIFICATION BY USE OF THE LONGITUDINALLY VARIABLE PRESSURE GRADIENT

by

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The problem of finding effective means of heat transfer intensification in gas-cooled reactors is still actual and progress in this direction may lead to significant improvements in reactor performances. The means used today, i.e. extended surfaces and surface roughening, are still not effective enough.

Especially high rates of heat transfer are found in fluids flowing normally to banks of closely spaced tubes and in beds of spherical particles. In both cases successive enlargements and narrowings in flow passages with large variations of the longitudinal pressure gradient are found. The study of fluid flow in diffusers reveals longitudinal vortices formed on the walls which break up on the edge of the boundary layer thus causing a high degree of turbulence in the stream. This effect must have an influence on the heat transfer rates. On the other hand, it has been proved that the degree of turbulence influences heat transfer in converging passages.

On the ground of the above analysis a preliminary investigation has been undertaker of heat transfer in an annular diffuser which has shown a substantial increase in heat transfer rates in comparison with the flow with a zero pressure gradient. The experimental investigation proceeded in a two-dimensional apparatus described in this paper. The test section consisted of a rectangular channel with two walls profiled in such a way as to form a succession of diffusing and converging sections with a half angle of 8°. The profiled walls were heated electrically and local wall temperatures measured along the channel by numerous thermocouples. The velocity and temperature profiles in the fluid were measured in four cross-sections. The static pressure distribution along the test section was also measured.

The experimental data show a considerable influence of the adverse pressure gradient on the heat transfer rate. The Stanton number based on the local flow area increases steadily along the diffuser up to more than twice in comparison with the flow without a pressure gradient. The intense turbulence created in the diffusing section influences substantially the heat transfer rate in the converging section too. The pressure loss coefficient which increases along the diffuser is greatly lowered in the converging section indicating a pressure energy recovery in this section.

The above results, obtained for a single geometry, show that the pressure gradient effect can be used successfully for heat transfer intensification with gas cooling. Other geometries are being tested in order to find an optimum combination of parameters which influence heat transfer and fluid flow.